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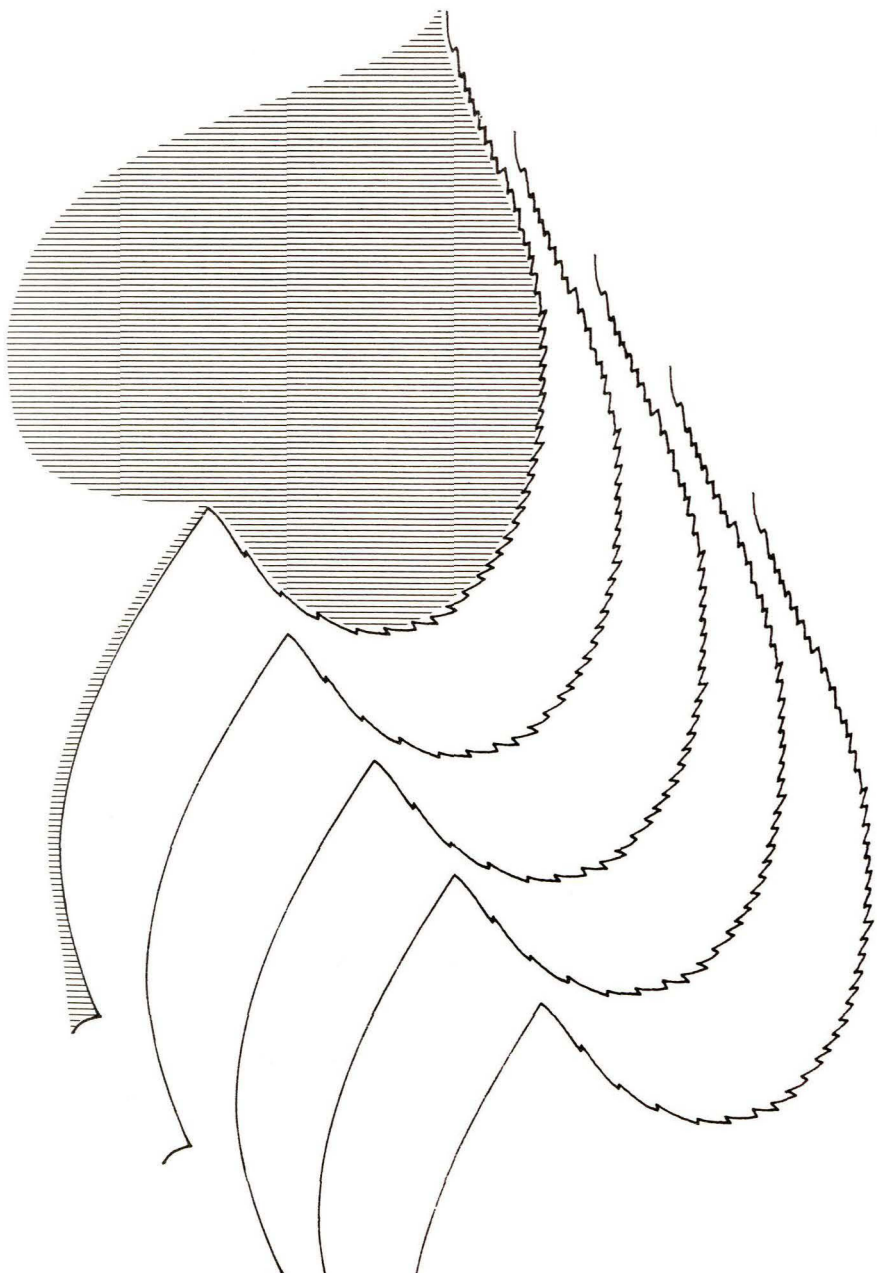

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POPULUS SPECIES AND HYBRID CLONES RESISTANT TO *MELAMPSORA*, *MARSSONINA*, AND *SEPTORIA*[1]

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Planting hybrid poplars has increased in recent years in the north central United States. Unfortunately, many of the hybrids that have been planted are highly susceptible to several damaging diseases and few studies have been done to test their susceptibility to the diseases prevalent in the area (Schipper 1976, Ostry and McNabb 1985). Leaf rust caused by *Melampsora medusae* Thuem., leaf spot and shoot lesion caused by *Marssonina brunnea* (Ell. and Ev.) Magn., and leaf spot and canker caused by *Septoria musiva* Peck are major threats to poplar production in the north central United States (Ostry and McNabb 1983). Selecting clones with high levels of resistance to these pathogens is the most desirable form of disease control (Ostry and McNabb 1983, Widen and Schipper 1981, Castellani and Cellerino 1964). Therefore, successfully establishing and managing high-yielding poplar plantations in the north central U.S. will depend upon planting clones that are resistant to these major pathogens. This study was undertaken to screen the *Populus* selections and hybrids that have been developed during the last four decades for resistance to *M. medusae*, *M. brunnea*, and *S. musiva*.

MATERIALS AND METHODS

Dormant hardwood cuttings from 499 *Populus* clones representing 40 hybrids and species were provided by the following people: Mr. Allan Allyn, Consolidated Packaging Corp., Ft. Madison, IA; Dr. Robert Stack, Department of Plant Pathology, North Dakota State University, Fargo, ND; Dr. Walter Bagley, University of Nebraska, Lincoln, NE; Dr. Louis Zsuffa, Canada Ministry of Natural Resources, Maple, Ontario; and Dr. M. E. Demeritt, Northeastern Forest Experiment Station, Durham, NH.

Plantations were established in 1978 near Rhinelander, WI; Rosemount, MN; and Rhodes, IA. The Rhinelander site was prepared by plowing and roto-tilling. The sites at Rosemount and Rhodes were prepared by plowing, disking, and applying Treflan®[2]. Ten cuttings of each clone were planted at 0.3 m spacing within rows and 2.8 m between rows—at Rhinelander, however, spacing between rows was 1.2 m. Clones were not replicated within plantations. Weeds were controlled with Roundup® for the first 2 years and by mowing thereafter at Rosemount and Rhodes. At Rhinelander Roundup® was used until the crowns closed and reduced weed competition. Trees were irrigated with a trickle irrigation system at Rhinelander only.

Trees were evaluated for disease severity three times each year from 1979 through 1981. A scale of 0 (absent or trace) to 3 (premature defoliation) was used to rate foliar diseases. Branch and stem cankers caused by *S. musiva* were rated as either 0 (absent) or 1 (present). The final score was based on the ratings from all 3 years. Tree survival and height were recorded in September 1981.

RESULTS AND DISCUSSION

Results of this study clearly illustrate the importance of selecting disease-resistant *Populus* clones for planting in the north central United States. Resistance to *Melampsora, Marssonina*, and *Septoria* differed greatly among the *Populus* species and hybrids tested (tables 1 and 2). Many clones were found unsuitable because of their susceptibilty to one or more diseases. Some clones were affected by all three pathogens, however, one usually predominated. Incidence and severity of *Melampsora* remained constant from year to year. By contrast, *Marssonina* and *Septoria* increased in severity each year.

[1]*Journal Paper J-12045 of the Iowa Agriculture and Home Economics Experiment Station, Ames, IA. Projects 2210 and 2524.*

[2]*Mention of trade names does not constitute endorsement by the USDA Forest Service.*

Table 1.--Disease ratings[1/], mean height growth, and mean survival of 150 Populus clones representing 38 hybrids, one named selection of the species P. deltoides, and one named selection of P. nigra growing in Minnesota, Iowa, and Wisconsin plantations 1979-1981

Number of clones	Hybrid parentage or species selection	Septoria leaf spot	Septoria canker	Marssonina leaf spot	Melampsora leaf rust	Height class[2/] MN	IA	WI	Mean survival (%) MN	IA	WI
8	P. nigra X P. laurifolia	1-3	1	2-3	0-1	5	4	9	41	76	72
3	P. nigra X P. trichocarpa	1-2	1	3	1-2	7	6	10	37	43	64
10	P. nigra var. Charkowiensis X P. nigra var. caudina	0-3	1	1-3	0-3	7	8	9	67	80	54
2	P. nigra var. Charkowiensis X P. nigra Incrassata	1-2	1	2	1	6	7	9	65	85	55
3	P. nigra var. Charkowiensis X P. deltoides	0-2	1	1-2	0-1	8	9	9	75	85	60
1	P. nigra var. Charkowiensis X (P. X berolinensis)	1-2	1	2	1	5	5	10	60	100	80
1	P. nigra var. Charkowiensis X (P. euramericana Robusta)	0-1	0	2	1	9	10	6	90	90	60
5	P. nigra var. Charkowiensis X P. trichocarpa	1-2	1	1-3	1	7	6	10	75	88	54
1	P. nigra var. betulifolia X P. trichocarpa Andover	1	1	3	1	5	--	9	29	--	71
1	P. nigra X (P X euramericana Eugenii)	1-2	0	3	1[3/]	9	8	--	57	86	--
6	P. nigra var. betulifolia X P. trichocarpa	1-2	0-1	2-3	1	8	5	9	85	80	79
3	P. nigra var. betulifolia X P. nigra Volga	1-2	0-1	1-2	0-1	8	9	6	77	70	50
1	P. nigra var. Italica Lombardy	0-1	0	0	1	5	6	10	22	78	89
3	P. maximowiczii X P. trichocarpa	1-2	0-1	0-2	1	5	4	10	53	63	54
5	P. maximowiczii X (P. X berolinensis)	1-2	0-1	1-3	1	6	5	10	69	71	73
1	P. maximowiczii X P. nigra var. plantierensis	1	1	0	1	7	5	11	43	83	86
1	P. Baatanicorum Vitrum X P. nigra Volga	0-1	1	1	1	6	7	6	56	100	33
2	P. Baatanicorum Vitrum X P. trichocarpa	2	0-1	2-3	1	5	5	8	60	55	50
1	(P. X Petrowskyana) X P. nigra var. caudina	1-2	1	3	2	6	6	9	80	60	60
1	(P. Rasumowskyana) X P. nigra var. caudina	1	1	2	1	4	3	10	90	90	80
9	P. candicans X (P. X berolinensis)	1-2	0-1	2-3	1	6	4	10	66	61	58
2	P. simonii X (P. X berolinensis)	1	0-1	1-3	1	9	6	4	75	60	55

(Table 1. continued)

Number of clones	Hybrid parentage or species selection	Septoria leaf spot	Septoria canker	Marssonina leaf spot	Melampsora leaf rust	Height class 2/ MN	IA	WI	Mean survival (%) MN	IA	WI
1	P. balsamifera X P. deltoides Jackii 4	0-1	0	2	1	7	6	4	70	30	70
9	P. X euramericana	0-1	0	2-3	1-2	9	8	7	36	88	58
22	P. deltoides X P. trichocarpa	1-3	1	1-3	1-3	5	6	6	43	73	37
1	P. deltoides var. occidentalis Sargentii X P. nigra Italica	1	1	1	1	--	5	6	--	44	30
2	P. deltoides var. occidentalis Sargentii X (P. berolinensis) Rossica	1-2	1	1-2	1	4	4	10	52	65	66
1	P. deltoides var. occidentalis Sargentii X P. simonii	0-1	0	2	2	4	5	4	30	70	30
16	P. deltoides X P. nigra var. caudina	0-1	0-1	1-3	1-2	8	8	8	68	79	62
2	P. deltoides X P. nigra Volga	0-1	0-1	2-3	1	7	7	5	60	75	57
2	P. deltoides X P. nigra var. plantierensis	1	1	2-3	1	5	7	8	45	63	34
1	P. deltoides var. occidentalis X P. balsamifera Northwest	1	0-1	1	3	3	3	3	60	100	50
1	P. deltoides X P. grandidentata	1	1	2	1	--	9	4	--	80	60
1	P. deltoides Siouxland	1	1	1	1	--	6	10	--	50	70
11	P. deltoides var. angulata X P. trichocarpa	1-3	1	2-3	2-3	6	7	7	50	67	50
2	P. deltoides var. angulata X P. nigra Volga	0-1	0	3	1	6	6	10	55	35	55
2	P. deltoides var. angulata X P. deltoides	1	0	1-3	1	7	4	9	27	20	20
2	P. deltoides var. angulata X (P. X berolinensis)	1-2	0-1	2-3	1-2	5	7	11	34	62	39
2	P. deltoides var. angulata X P. nigra Incrassata	1-2	0-1	1-2	1	6	6	9	40	62	15
2	P. deltoides var. angulata X P. nigra var. plantierensis	0-1	0-1	3	1	4	7	8	40	95	80

1/ Marssonina ratings based on data from all three locations, Septoria on data from Minnesota and Iowa, and Melampsora from Wisconsin data. A range is given to indicate variation among clones within a hybrid or between plantations in the case of species clones.

Foliar Disease Rating
0 = Absent or trace
1 = Slight, lower crown only
2 = Medium, throughout crown, defoliation in lower crown only
3 = Severe, defoliation throughout crown

Canker Rating
0 = Absent
1 = Branch and stem cankers

2/ Height Class (m)
1 = 0.10 - 0.50
2 = 0.51 - 1.00
3 = 1.01 - 1.50
4 = 1.51 - 2.00
5 = 2.01 - 2.50
6 = 2.51 - 3.00
7 = 3.01 - 3.50
8 = 3.51 - 4.00
9 = 4.01 - 4.50
10 = 4.51 - 5.00
11 = 5.01 - 5.50

3/ None alive at Rhinelander, rating based on Rosemount data only.

Table 2.--Disease ratings[1/], mean height growth, and mean survival of 11 *Populus deltoides* provenances growing in Minnesota, Iowa, and Wisconsin plantations 1979-1981

Provenance	Number of families	Number of clones	*Marssonina* leaf spot	*Melampsora* leaf rust	Height class[2/] MN	IA	WI	Mean survival (%) MN	IA	WI
Minnesota	26	103	1-2	1-2	6	6	7	38	54	25
Wisconsin	2	6	2	2	7	5	8	44	49	29
South Dakota	1	5	1	3	5	2	-	27	3	0
Northern Illinois	24	71	0-2	1	6	4	6	32	32	29
Nebraska	8	30	1-2	1-2	4	4	3	18	34	3
Pennsylvania	1	3	1	1	5	4	7	67	63	30
Ohio	11	35	1	0-2	5	4	8	36	40	24
Indiana	5	21	1	0	6	5	7	43	56	32
Missouri	16	56	0-1	1-2	6	4	6	36	19	9
Kansas	3	10	1	1	4	3	3	44	9	7
Southern Illinois	6	9	0-1	1-3	7	4	7	21	2	12

[1/] *Marssonina* ratings based on data from all three locations, *Melampsora* ratings based on data from Rhinelander. A range is given to indicate variation within families. Severity of *Septoria* leaf spot was minor and *Septoria* canker was absent.

Foliar Disease Rating

0 = Absent or trace
1 = Slight, lower crown only
2 = Medium, throughout crown, defoliation in lower crown only
3 = Severe, defoliation throughout crown

[2/] Height Class (m)

1 = 0.10 - 0.50
2 = 0.51 - 1.00
3 = 1.01 - 1.50
4 = 1.51 - 2.00
5 = 2.01 - 2.50
6 = 2.51 - 3.00
7 = 3.01 - 3.50
8 = 3.51 - 4.00
9 = 4.01 - 4.50
10 = 4.51 - 5.00
11 = 5.01 - 5.50

Survival and growth of hybrid poplar clones were generally greater than that of the *P. deltoides* clones at all locations (tables 1 and 2). Early tree mortality was attributed to planting failure and winter injury. Subsequent mortality of many of the hybrid clones was due to stem breakage at Septoria cankers or girdling by stress-related fungi such as *Cytospora chrysosperma* (Pers.) Fr., *Phomopsis macrospora* Kobayashi and Chiba or *Dothichiza populea* Sacc. & Br. Survival of the *P. deltoides* clones was poor, however, their greater resistance to Septoria leaf spot and canker sharply contrasted the majority of the hybrid poplars tested.

This study was designed to obtain information on disease severity but not to determine the growth potential of individual clones. Therefore, height classes are given only to serve as a general guide to the productivity of each clone under existing test conditions. Tree growth generally was greater at Rhinelander for most *P. deltoides* and hybrid clones than at either Rosemount or Rhodes. This result was attributed to irrigation and intensive weed control at Rhinelander.

Incidence and severity of two of the three diseases studied differed greatly among the test sites. *Melampsora* leaf rust was most severe at Rhinelander where *Larix laricina*, the alternate host for *M. medusae*, was present. Disease symptoms were visible 2 months sooner on susceptible clones at Rhinelander than at either Rosemount or Rhodes. Highly susceptible clones usually defoliated completely by mid-August at Rhinelander. Mortality of severely affected clones was high. These same clones were only slightly affected in September at Rosemount and Rhodes.

Septoria leaf spot and canker was far more severe at Rhodes and Rosemount than at Rhinelander where leaf spot was slight and canker absent until 1983. Septoria canker was first detected in 1981 in other *Populus* test plantings near Rhinelander. Since then, Septoria canker has increased in severity to about the same level as at Rhodes and Rosemount.

Marssonina was common on susceptible clones at all three locations and caused severe premature defoliation and shoot lesions on some clones. Unlike *Melampsora* and *Septoria*, no major difference was detected in disease severity at the three sites.

Cankers caused by *Hypoxylon mammatum* (Wahl.) Mill. were found on two trees of two hybrid clones at Rosemount. The two hybrids were *P. nigra* var. *betulifolia* X *P. nigra* 'Volga' and *P. nigra* var. *betulifolia* X *P. trichocarpa*. Trees of three additional hybrid clones have been infected by *Hypoxylon* in commercial plantings in Michigan. Clones affected were *P. maximowiczii* X (*P.* X *berolinensis*), *P. candicans'* X (*P.* X *berolinensis*), and *P. deltoides* X *P. nigra* 'Incrassata' (Ostry, unpublished data). It is not known what the potential impact of this pathogen will be on these hybrids or how widespread the incidence of this disease will be in future plantations.

Variation across sites in tree survival and in the incidence and severity of diseases among the clones means that clones need to be evaluated under a wide range of field conditions at several locations before recommendations can be made on their growth potential and disease resistance. Careful consideration must be given to where test plantations are located and what pathogens are important in that area in order to accurately assess a clone's resistance to a specific pathogen.

Hybrid clones with *P. trichocarpa, P. laurifolia*, or *P. maximowiczii* as one parent were the most susceptible to Septoria canker. In contrast, cankers were found on only one *P. deltoides* clone. However, Septoria canker is considered a serious problem on *P. deltoides* in the southern United States (Filer *et al.* 1971).

Many of the hybrids evaluated in this study previously had been rated for resistance to *Septoria* during their selection in the northeastern United States. Clones in that trial that were susceptible to canker but produced high volumes of wood were not discarded because of the belief that they would be suitable for mini-rotation management (Schreiner 1971). Results of this study indicate that this strategy will not work in the north central region. Susceptible clones should not be grown in this region even under short rotation management because of the potential impact of *S. musiva*.

Susceptibility to Septoria canker differed little within a parental type at a particular location. Hybrids with one or both parents belonging to the section Tacamahaca were uniformly susceptible to *Septoria*. The 38 hybrids tested included 148 clones. Twenty hybrids were free from Septoria canker at either Rosemount or Rhodes or at both locations. From this group, 24 clones (16 percent) were free from canker at Rosemount and Rhodes. An additional 13 clones (9 percent) had cankers at only one location. Included in this second group were a few clones with no surviving trees at one location because of planting failure. The remainder of the hybrid clones had cankers at both locations.

Of the hybrids tested, the *P.* X *euramericana* clones were the most resistant to *Septoria*. However, among these clones were some that could not be recommended because of their high susceptibility to *Marssonina*. These clones commonly defoliated prematurely and diedback.

Although clones were rated for the leaf rust caused by *M. medusae*, evidence exists that at least two other *Melampsora* species or intermediate types exist in the north central region (Stack and Ostry 1983). Recent reports indicate that host-specific races of *Melampsora* exist in Australia and in Europe (Chandrashekar and Heather 1980, Singh and Heather 1982, Pinon and Bachacou 1984). Thus, it is important for *Populus* breeders and growers to continue monitoring for leaf rust, especially on clones that have previously been free from disease.

Results of this study and that of McNabb *et al.* (1982) indicate that clones susceptible to Septoria canker cannot be managed successfully in short rotation (5 to 15 year) fiber-production plantations. Therefore, it is important that resistance to *S. musiva* be included in *Populus* selection and breeding programs. In addition, clones should not be released for commercial trade until they have been thoroughly tested for disease resistance in the areas where they will be grown. Persons interested in growing hybrid poplars should obtain the original clone number as well as varietal or cultivar name of available planting stock so that inquiry can be made as to its disease resistance before purchase.

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PESTICIDE PRECAUTIONARY STATEMENT

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

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Trees were rated for their resistance to the foliar pathogens *Melampsora medusae* and *Marssonina brunnea* and the foliar and canker pathogen *Septoria musiva*. Many clones were found to be too susceptible to one or more diseases to be safely planted in the north central United States. The *P. X euramericana* clones were the most resistant to *Septoria*.

KEY WORDS: *Septoria musiva, Melampsora medusae, Marssonina brunnea*, intensive culture.

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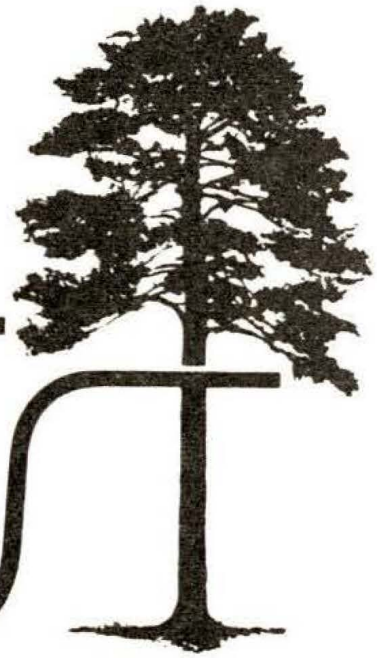

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